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Atomic friction and dissipation experiments with 2d materials

Ernst Meyer[1)*], Zhao Liu[1)], Antoine Hinaut[1)], Remy Pawlak[1)], Marcin Kisiel[1)], Alexina Ollier[1)] and Thilo Glatzel[1)]

[1)]Department of Physics, University of Basel, Klingelbergstr. 82, CH-4056 Basel, Switzerland

*Corresponding author: Ernst.meyer@unibas.ch

2d materials, such as graphene, are of interest for lubrication of micro- or nano-scale contacts. We investigate the formation of Moiré patterns of graphene deposited on platinum. Atomic-scale friction experiments show a dependence on the size of the Moiré periodicity. A second type of experiments is non-contact force microscopy experiments above free-standing graphene. We do find enhanced dissipation levels at characteristic energies, which are related to quantum dots localized on the graphene surface.

Keywords (from 3 to 5 max): atomic friction, 2d materials, graphene, quantum dots

1. Introduction

2d materials represent the ultimate lubrication film, reduced to single atom thickness. A number of studies have shown that graphene has exceptional frictional properties on the nanoscale. In combination with nanodiamond particles, it was found that the lubrication can be even achieved on a macroscopic scale [1].

2. Methods

In the present study, we use ultrahigh vacuum conditions to prepare graphene samples on metallic substrates. A second strand of experiments uses the pendulum AFM above free-standing graphene membranes [2].

Results and Discussion

The Moiré patterns of graphene deposited on platinum are characterized by high resolution force microscopy in non-contact mode. We find a number of different Moiré periodicities, which arise due to the mismatch between the platinum substrate and graphene. Atomic friction studies were performed with different normal loads and show characteristic differences for the moiree patterns.

The second strand of experiments is performed with a hanging cantilever geometry, where the frequency shift and damping coefficient are measured above the free-standing graphene surface. The sample can be biased and we do find jumps of the frequency shift as well as enhanced damping coefficient at specific voltages. This type of behavior was previously observed on quantum dot systems of semiconductors [3]. We conclude that quantum dots are formed on the graphene surface, which lead to dissipation due to inelastic tunneling. We do observe capacitive coupling and observe that the peaks of damping shift towards higher voltages for increasing separations.

3. References

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